**DRAFT DATA QUALITY OBJECTIVES FOR WEST LAKE CORE SAMPLING**

| Study | Step 1 - State the Problem | | | Step 2 - Identify the Decision | | |
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| | **Problem Statement** | **Conceptual Site Model of Environmental Hazard to be Evaluated** | **Alternative Approaches** | **Principal Study Questions** | **Alternative Actions** | **Decision Statement** |
| **"RIM to Atmosphere Study"** | A subsurface smoldering event (SSE) in one of the non-radiological OU2 disposal cells was reported in December 2010. Although the SSE is more than 1,000 feet away from the nearest radiologically-contaminated OU1 cell, the public and the media are concerned that the SSE may eventually reach the radiologically-contaminated materials. | Subsurface RIM to atmosphere via particulates/gasses: Some have hypothesized that an SSE could cause the release of subsurface RIM to the atmosphere. The mode of release would presumably be via release of RIM on particulate matter or RIM released in a gas phase. | 1) Estimate a worst case particulate release using existing site soil data.<br><br>2) Estimate worst case exposure to a particulate release by experimentally determining the worst case radionuclide activity of smoke (pCi/ug basis) and then evaluate exposures for various particulate loading. | Could the action of an SSE cause increased mobility of radionuclides of concern from subsurface RIM to the atmosphere? | If the study finds an SSE causes increased mobility, further study may be warranted. If the study indicates no measurable increase in mobility of the study radionuclides, further study is not warranted. | Determine whether an SSE could result in increased mobility of radionuclides of concern. |
| **"Leaching Study"** | | Subsurface RIM to leachate/groundwater ("steam front"): Some have hypothesized that an SSE could cause a "stream front" that would push water through nearby ("non-pyrolyzed") RIM causing leaching of radionuclides to the aqueous phase. | 1) Use existing chemical equilibrium modeling codes or soil-to-groundwater partitioning coefficients ($K_d$ values) to evaluate transport of radionuclides from RIM (see Huck et al Modeling of $^{226}Ra$ from Ra-Ba $SO_4$ Sludges use of USGS PHREEQE code)<br><br>2) Model a worst case scenario | What liquid extract concentrations are yielded by analyzing RIM with the Toxicity Characteristic Leaching Procedure (TCLP)? | None | Determine the extract concentrations of the study radionuclides yielded by subjecting RIM samples to a standard TCLP and a modified TCLP where the sample and leaching solutions is heated. |
| **"Radon Study"** | | Release of radon to atmosphere: Some have hypothesized that an SSE could increase the rate of radon release from the subsurface. Possible increase in radon as noted by ORD comments to the EMSI SSE evaluation report: http://www.epa.gov/region07/cleanup/west_lake_landfill/pdf/west-lake-etsc-observationsonemsireport.pdf<br><br>An SSE event could cause a change in subsurface moisture and/or the physical/chemical makeup of the RIM which may affect the radon emanation coefficient and radon flux. The radon emanation coefficient quantifies the fraction of radon that escapes from solid material into the adjacent pore space (see Strong and Levins 1981). | 1) Use modeling software (RAECOM, RESRAD) to investigate changes to radon flux with changes to subsurface conditions (moisture loss, etc.). | How does moisture content and combustion/pyrolysis of RIM affect the site-specific radon emanation coefficient? | None identified | Determine the radon emanation coefficients of West Lake RIM at various moisture content and states of combustion/pyrolysis. |

| Study | Step 3 - Identify Inputs to the Decision | | | |
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| | **List of analytes to measure** | **Procedure for obtaining samples** | **Laboratory treatments to be studied** | **Experimental procedure** |
| "RIM to Atmosphere Study" | Measure bulk sample and air fraction for:<br>Uranium-238<br>Thorium-230<br>Radium-226<br>Lead-210<br>Bismuth-210<br>Polonium-210<br>Barium | Sampling Procedure<br>-screen samples in field for background vs elevated activity<br>-select 3 samples with elevated activity for testing<br>-amount material per sample = 10 to 100 grams<br>-package to maintain moisture and ship to lab<br><br>Field recorded:<br>lat/long, depth, downhole gamma, sample screening count rate with 3x3 detector if possible use standard geometry. | Heating is treatment<br>Stage 0: room temp (RT)<br>Stage 1: RT - 105 C ("water loss stage")<br>Stage 2: 105 C - 260 C (500 F) ("pyrolysis stage")*<br><br>Alternative temperature ranges could be determined based on a temperature vs sample weight loss curve determined via thermogravimetric analysis (TGA) analysis of a subsample.<br><br>Note: auto-ignition of paper = 218 - 246 C (in air) | Heat bulk sample and obtain air sample (via capture of particulates and condensing gasses in an impinger solution) from each treatment.<br><br>Testing parameters:<br>temp ramp rate = _____<br>duration for each stage = _____<br>flow rate through air filter = _____<br>chamber atmosphere: bottled air, aged 21 days (to provide 21% $O_2$ as a worst case)<br><br>Steps: 1) weigh bulk sample, 2) place in chamber, 3) start flow through impinger, 4) ramp up temp, 5) hold at temp, 6) collect impinger solution, 7) weigh bulk sample, 8) repeat #1-7 for each stage, 9) determine activity of bulk sample and impinger solution<br><br>Anticipated number of samples/conditions/replicates:<br>6 samples submitted x 3 conditions (stage 0, 1, 2) = 18 |
| "Leaching Study" | Measure bulk sample and leachate for:<br>Uranium-238<br>Thorium-230<br>Radium-226<br>Lead-210<br>Bismuth-210<br>Polonium-210<br>Gross alpha/beta<br>Barium (or other ICP cations) | see above | Heating is treatment<br>Non-heated: Room temperature<br>Heated: Just below boil | Preform TCLP analysis using heated and non-heated conditions.<br><br>Steps:<br>1) Homogenize bulk sample, 2) obtain representative subsamples, 3) preform a heated and non-heated TCLP by EPA Method 1311<br><br>Anticipated number of samples/conditions/replicates:<br>3 samples submitted x 3 replicates x 2 conditions (heated/not heated) = 18 |
| "Radon Study" | Radon-222 (as an emanation coefficient) | see above<br>-minimum sample size = ~100 grams | Moisture treatments proposed:<br>-dry<br>~1 wt % moisture content<br>~2 wt % moisture content<br>-saturated<br>*(moisture content treatments selected based on Strong/Levins result)*<br><br>Heat treatments are:<br>-As received (no heating)<br>-"Pyrolyzed" (sample subjected to 260 C for 2 hours)<br><br>(4 x 2 = 8 treatments per sample) | Determine radon emanation coefficient for the various treatments per a method similar to Strong and Levins (1981). (No "column testing" for determination of a flux is proposed at this time.)<br><br>Steps:<br>1) Dry and sieve (No. 10 mesh) received sample<br>2) Determine radon emanation coefficient for various treatments<br>3) Analyze sieved sample for isotopic uranium/thorium and Ra-226<br><br>Anticipated number of samples/conditions/replicates:<br>3 samples submitted x 1 replicate x 8 conditions = 24 radon emanation coefficient determinations |

| Study | Step 3 - Identify Inputs to the Decision (continued) | | Step 4 - Define the Boundaries of the Study | | | |
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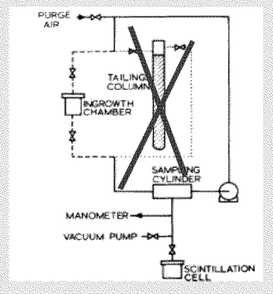
| | **List of measurements needed from lab** | **Analytical Methods and Measurement Sensitivity** | **Target Population** | **Spatial and Temporal Boundaries** | **Practical Constraints on Collecting the Data** | **Define the Scale of Inference** |
| **"RIM to Atmosphere Study"** | 1) before/after digital photo of bulk sample at each stage<br>2) activity of captured particulates/gasses for each stage [pCi]<br>3) activity of bulk sample (after Stage 2) [pCi/g]<br>4) weight of bulk sample before/after each stage [g]<br>5) lab notes indicating any observations of smoke<br>6) average flow rate [mL/min]<br>7) duration of each stage [minutes] | Particulate/gas activity:<br>Bottled air flows through chamber with bulk sample picking up particulates/gas which are then deposited in impinger solution. Impinger solution is analyzed for analytes listed in Step 2.<br>MDA goal = 1 pCi<br><br>Bulk sample activity:<br>At end of last test stage, bulk sample is analyzed for the analytes listed in Step 2. Preference is to analyze a large aliquot size so that reported activities are representative of the bulk sample.<br>MDA goal = 1 pCi/g | Fraction of the radionuclide activity (for each of the studied radionuclides) released from the bulk sample via airborne particulates and condensing gases | Spatial: Bulk samples of landfill material collected from RIM and non-Rim areas<br><br>Temporal: No boundaries identified | Sensitivity required to detect activity of particulates/condensing gases captured by impinger solution. | If there is no significant difference in the RIM activity released to air for the various treatments (heating), it will be inferred that an SSE, through pyrolysis of subsurface RIM, would not cause a release of the studied radionuclides to the atmosphere.<br><br>If higher activity is found in the impinger solution for the pyrolysis (heated) stages as compared to the non-heated stages, it will be inferred that there is a possibility that an SSE, through pyrolysis of the subsurface RIM, could cause a release of the studied radionuclides to the atmosphere. A plot of activity of the impinger solution (pCi) vs total sample activity (pCi) would show if the activity released to air to sample activity. It would not be possible from this study to infer (or estimate) the amount of radionuclide that would actually be released due to pyrolysis of RIM or otherwise assess risk.<br><br>If all impinger solution measurements for the treatments simulating an SSE are non-detect, no inference can be made. |
| **"Leaching Study"** | 1) Radionuclide and barium in leachate [pCi/L and mg/L]<br>2) Radionuclide and barium in bulk sample [pCi/g and mg/kg]<br>3) Was TCLP Extraction Fluid #1 (pH = 4.93) or #2 (pH 2.88) used? | Leachate:<br>MDA goal = 0.5 pCi/L<br><br>Bulk sample activity:<br>After TCLP procedure, bulk sample is analyzed for the analytes listed in Step 2. Preference is to analyze a large aliquot size so that reported activities are representative of the bulk sample.<br>MDA goal = 1 pCi/g | Total amount of radionuclide leached from the bulk sample (solid phase) to the leachate (aqueous phase). | Spatial: Bulk samples of landfill material collected from RIM and non-Rim areas<br><br>Temporal: Amount of leaching in the landfill and in simulation is assumed to be governed by thermodynamic equilibrium and not rate limited. | None identified | TCLP results (pCi/L) indicate relative "leachability" of radionuclides from RIM wastes to landfill leachate. |
| **"Radon Study"** | 1) As received moisture content of bulk sample<br>2) Radon emanation coefficient per treatment per sample<br>3) Isotopic uranium/thorium and Ra-226 of sieved sample | See Levins and Strong 1981<br>  <br> | Radon emanation coefficient | Spatial: Bulk samples of landfill material collected from RIM area<br><br>Temporal: See Levins and Strong procedure regarding in-growth times | None identified | The radon emanation coefficients determined vs moisture content/heat-treatment would be representative of the site and could be used in future radon modeling efforts.<br><br>Study would not provide information to infer changes in radon flux due to landfill settling, development of fissures in cover due to drying, or any advective transport of radon. |